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Chapter 22. Ecosystem Restoration

Ecosystem restoration improves the condition of our modified natural landscapes and biological communities to provide for their sustainability and for their use and enjoyment by current and future generations. Few, if any, of California's ecosystems can be fully restored to their pre-development condition. Instead, efforts focus on rehabilitation of important elements of ecosystem structure and function. Successful restoration increases the diversity of native species and biological communities and the abundance of habitats and connections between them. This can include reproducing natural flows in streams and rivers, curtailing the discharge of waste and toxic contaminants into water bodies, controlling non-native invasive plant and animal species, removing barriers to fish migration in rivers and streams, and recovering wetlands so that they can store floodwater, recharge aquifers, filter pollutants, and provide habitat.

Overview

This strategy focuses on restoration of aquatic, riparian and floodplain ecosystems because they are the natural systems most directly affected by water and flood management actions, and are particularly vulnerable to the impacts of climate change. Today, water and flood planning must aim to prevent ecosystem damage and reduce long-term maintenance costs. Future water and flood management projects that fail to protect and restore their ecosystems will face reduced effectiveness, sustainability, and public support.

Restoration generally emphasizes recovery of at-risk species and natural communities, usually those whose abundance and geographic range have greatly diminished. These include several fishes, such as Delta smelt, longfin smelt, green sturgeon, Chinook and Coho salmon, and steelhead rainbow trout; and riparian and wetland habitats and their member species, including valley elderberry longhorn beetle, giant garter snake, and several migratory bird species. Successful restoration of aquatic, riparian, and floodplain species and communities ordinarily depends upon at least partial restoration of physical processes that are driven by water. These processes include the flooding of floodplains, the natural patterns of erosion and deposition of sediment, the balance between infiltrated water and runoff, and substantial seasonal variation in stream flow. Another barrier to ecosystem restoration—displacement of native species by exotics—often results from the diminution of these same physical processes.

As an example, nearly all California waterways are controlled to reduce the natural seasonal variation in flow. Larger rivers are impounded to capture water from winter runoff and spring snowmelt and release it in the dry season. Many naturally intermittent streams have become perennial, often from receipt of urban wastewater discharges or from use as supply and drainage conveyances for irrigation water. The Sacramento-San Joaquin Delta (the Delta) has become more like a year-round freshwater lake than the seasonally brackish estuary it once was. In each case, native species have declined or disappeared. Exotic species have become prevalent, often because they are better able to use the greater or more stable summer moisture and flow levels than the drought-adapted natives.

Current Activities

Many important recovery efforts that affect water and flood management occur throughout California and are implemented by public agencies, private agencies, non-profits, volunteers or a combination of all the above. Some examples appear below.

The first example of recovery and restoration planning is in the Delta, where several efforts are under way. Water users are seeking to secure long-term assurances for Delta exports by formulating a Bay-Delta Conservation Plan (BDCP). BDCP will identify how to improve the design and operation of the State and federal water projects and restore and manage habitats in the Delta. Once adopted, the BDCP will be implemented over the next 50 years. The schedule for release of the draft EIR/EIS is summer of 2012. The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established a Delta Stewardship Council to develop a Delta Plan. State- and local-agency actions related to the Delta must be consistent with the Plan. The Delta Reform Act also required the State Water Resources Control Board to develop flow criteria for the Delta ecosystem. The Board adopted new flow criteria for the Delta in 2010. The flow criteria will be incorporated into the Delta Plan and the BDCP.

Another example of restoration planning is the Central Valley Project Improvement Act (CVPIA) of 1992, which mandates changes in the management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife. One component of the CVPIA is the Anadromous Fish Restoration Program (AFRP). The AFRP has a goal of at least doubling the natural production of anadromous fish in Central Valley streams. AFRP has helped implement nearly 200 projects to restore natural anadromous fish production.

A third example is the Central Valley Joint Venture (CVJV), which protects, restores, and enhances wetlands and associated habitats for waterfowl, shorebirds, and songbirds in the Central Valley, through partnerships among conservation organizations, government agencies, and private landowners. The CVJV Implementation Plan focuses on wetlands and the values they provide to birds. It contains Central Valley-wide objectives, expressed as acres of habitat of seasonal and semi-permanent wetlands, riparian areas, rice cropland, and other waterfowl-friendly agricultural crops.

Fourth, the Southern California Wetlands Recovery Project, chaired by the California Natural Resources Agency and supported by the Coastal Conservancy, works to acquire and restore wetlands, watersheds, and streams in coastal Southern California. The aim is to reestablish a mosaic of fully functioning wetlands with a diversity of habitat types and connections to uplands, so as to preserve self-sustaining populations of species. About 120 projects are in process or complete, with over 2,700 acres acquired and protected and over 800 acres enhanced or restored. These include Tijuana Estuary, South San Diego Bay National Wildlife Refuge, Bolsa Chica, Ballona wetlands, and the Santa Clara River Parkway.

The final example is the Santa Ana River watershed program that successfully integrates habitat restoration and endangered species recovery with flood control, groundwater recharge, and water quality improvement. Prado Dam is a key component, serving both flood protection and water storage. Upstream of the dam lies a habitat area that has expanded over the last 20 years to support both the largest patch of riparian forest and the largest number of the endangered Bell's vireo (a songbird) in Southern California. The invasive giant reed displaces native vegetation along the river, impedes flow during floods, and is a heavy water user. An aggressive program of giant reed removal serves to improve habitat for the vireo,

reduce flood risk, and recover more water. The river is the main source of recharge for the Orange County groundwater basin and consists mainly of treated wastewater from upstream cities. Constructed wetlands remove nitrogen from river water.

Potential Benefits of Ecosystem Restoration

Provision of Ecosystem Services

California rivers and their associated floodplain ecosystems provide numerous public and private benefits that can be thought of as goods and services. These include water purification, groundwater recharge, erosion control, storage of floodwaters, hydropower generation, soil-building, pollination, wood products, carbon sequestration (greenhouse gas mitigation), fisheries and wildlife and recreation.

Market opportunities for nature's services, often called "payments for ecosystem services", are contracts negotiated with landowners to manage land and water so as to maintain or enhance the specified services. A new direction in efforts to protect and restore ecosystems is to develop those markets. Numerous pilot projects are under way in California and elsewhere. They typically involve collaboration among diverse interests, agreement on a geographic boundary, identification of management practices, and –often the hardest step--economic valuation of the benefits derived from the practices. The projects also must identify beneficiaries and establish mechanisms for them to pay for goods and services they receive.

Estimation of the monetary value of nature's services can be important information for resource managers who normally see only the costs of ecosystem protection, but not the benefits, in their budgets. Examples of current and emerging projects appear in the Regional Reports, and include the following: farming for carbon capture and land subsidence reversal on islands in the Delta; forest, water and fire management in the Mokelumne River watershed; mountain meadow improvement in the Sierras and Cascades; and natural resource management in the Santa Ana River watershed.

Reliability of Water Supply

As ecosystem restoration actions help recover the abundance of endangered species, there should be fewer Endangered Species Act conflicts, particularly in the Delta. These conflicts repeatedly disrupt water supplies. Thus, one result of ecosystem restoration should be a more reliable water supply.

An example of a more direct water supply benefit is the restoration of meadows that occur in the headwaters of rivers and streams. Meadows have wide, shallow, vegetated channels that spread flood peaks across the meadow floodplain and recharge the underlying aquifer. In contrast, gully erosion drains groundwater stored in meadows and eliminates meadow wetlands. Meadow restoration reverses gully erosion and returns the vegetation to wetland and riparian forms. The US Forest Service estimates that meadow restoration in National Forests in the Sierra Nevada could add 50,000 to 500,000 acre-feet of groundwater storage per year. See the forest management strategy in this volume for further discussion.

Water Quality

The numerous ways that natural ecosystems contribute to water quality improvement are described in other resource management strategies in this volume. For the role of wetlands and riparian forests in filtering contaminants from runoff, see the chapters on pollution prevention and forest resource management. For the role of forests in preventing erosion and subsequent sedimentation of streams, refer

to the forest resource management strategy. Finally, the watershed management strategy explains that drinking water drawn from forested land requires less treatment than water derived from agricultural or developed land, because it is less contaminated.

Sustainability

Water and flood management projects that incorporate ecosystem restoration are likely to be more sustainable than those that do not. Projects are more sustainable (that is, they operate as desired with less maintenance effort) when they work with, rather than against, natural processes that distribute water and sediment. To include ecosystem restoration in a project usually requires a degree of return to more natural patterns of erosion, sedimentation, flooding, and instream flow, among others. This, in turn, makes such projects harder for natural processes to disrupt and easier to maintain. An expected benefit is cost savings over the life cycle of such projects because repair and maintenance should cost much less.

Climate Change Adaptation and Mitigation

Adaptation

Ecosystem restoration can play a role in climate change adaptation. The Central Valley Flood Protection Plan outlines the State's proposed response to a predicted climate regime of more frequent and larger floods. Part of that response is to increase the use of floodwater bypasses, by creating new ones and widening the existing set. Beyond their role in flood protection, bypasses return floodplains to a more natural function and allow restoration of native floodplain vegetation. In turn, this helps stabilize soils, increase groundwater infiltration and storage, and reduce flood-water velocities, bank erosion and sedimentation of streams. Furthermore, because a return to a more natural floodplain function makes more room for flood peaks in valley areas, it allows more reservoir capacity to be dedicated to water supply, rather than be set aside for flood-water storage.

The expected shift to more severe flooding may diminish the ability to continue to farm many areas, because the increased cost of recovery from floods could make farming uneconomical. However, making a clear dedication of land to expand flood-carrying capacity will reduce the flood risk on the remaining farmland and thus make that land more secure for agriculture

Mitigation

Ecosystem restoration can also play a large role in climate change mitigation. Because plant growth depends on the capture and incorporation of atmospheric carbon into plant tissue, trees and other plants sequester carbon. Growth rates of trees in low-elevation riparian forests in California are among the highest in the world, outside the tropics. Thus, significant expansion of riparian forest acreage in inland and coastal valleys could serve as a large carbon sink that offsets carbon emissions.

Flood Management

The principal opportunities for improvement in both flood and habitat management occupy the same spatial footprint and are affected by the same physical processes that distribute water and sediment in rivers and across floodplains. As suggested above, many actions taken for ecosystem restoration can also support more sustainable flood management.

Four major structural elements of flood management in California affect ecosystems: dams, levees, floodwater bypasses, and setback levees. Their flood management roles are clear. Dams impound floodwater and reduce peak flows. Levees keep rivers in their channels and off their floodplains. Bypasses allow controlled conveyance of floodwater across floodplains. Setback levees reduce water velocities and flood elevations, when compared to on-channel levees, and therefore sustain less erosion damage.

The combined use of dams and levees reduces the frequency and extent of floodplain inundation. In contrast, setback levees and bypass channels allow more frequent inundation of potential habitat space on floodplains. Native riparian and aquatic animal and plant communities of California are adapted to conditions of seasonal flooding. Thus, setback levees and bypasses are better tools to integrate habitat and flood protection than are dams and on-channel levees. Flood bypasses, in particular, can serve as important fish rearing habitat—a use of the Yolo Bypass today. The Yolo Bypass provides far better growth and survival for juvenile salmon than nearby channelized rivers that are now their main habitat.

Ecosystem restoration can improve flood protection by reducing levee erosion, increasing floodwater conveyance, deflecting dangerous flows away from levees, and strengthening levee surfaces. For example, levee erosion is a maintenance concern that often can be alleviated by slowing water velocity along the levee face. This can be done by setting the levee back and by growing plants on the lower levee slope and between the levee and the main channel. The vegetation reduces the force of water against the levee. Also, a new setback levee can be built with sound materials on a more stable foundation than many existing levees. The selection of appropriate vegetation is a key to reducing levee erosion while retaining the flood-carrying capacity of the stream channel.

A recent example of the use of suitable plants occurred at O'Connor Lakes on the Feather River downstream of Yuba City, where a right-angle bend in the levee had been subject to severe and repeated erosion. A technical analysis of the paths taken by floodwater identified areas of the river channel where forest could remain (instead of being cleared periodically), areas where restoration of native trees and shrubs would not interfere with flood flows, and areas where the vegetation needed to be low and flexible enough to smooth the way for floods. The latter area was planted with native grasses and herbs. Overall, the new design increased the area of native vegetation by 230 acres, protected existing habitat from removal, reduced the risk of levee erosion and the need for expensive levee repair, and reduced the cost of keeping the channel clear for floodwater conveyance. Thus, a cheaper and more effective way to maintain the flood channel was also better for fish and wildlife habitat.

As with floodwater bypasses, habitat for juvenile fishes can be developed with setback levees. One such project on the lower Bear River in Sutter County was contoured to drain water and fish back to the river when floodwaters recede, thus preventing fish stranding. The project also created several hundred acres of forest and grassland habitat. The new, larger, more durable levee, set back from the erosive forces of the river, improved flood protection for the urban area behind it.

Potential Costs of Ecosystem Restoration

A comprehensive statewide summary of the costs of ecosystem projects does not exist. However, as of 2011 the Ecosystem Restoration Program, now managed by California Department of Fish and Game, had funded 579 projects, worth about $718 million. About half of that amount was for riparian habitat, fish screens and improvements to water and sediment quality.

The Central Valley Project Improvement Act, since 1992, has spent approximately $629 million of State and federal money to do what it has been directed. For the past 10 years the United States Bureau of Reclamation and United States Fish and Wildlife Service have implemented one of the Nation's largest fish and wildlife restoration efforts.

The Central Valley Joint Venture has used a mix of public and private funds to accomplish their goals. Table 22-1 below (updated March 2011) illustrates the budgets and the acres of habitat conserved.

PLACEHOLDER Table 22-1 [Title to Come]

[Any draft tables, figures, and boxes that accompany this text for the advisory committee draft are included at the end of the chapter.]

As of 2010 the Southern California Wetlands Recovery Project has spent over $450 million completing projects from Santa Barbara county to San Diego county.

Major Issues Facing Ecosystem Restoration

Climate Change

Climate change will likely make preservation and restoration of key habitats more difficult. Perhaps the most important reason for this is an expected decline in the availability of moisture. A combination of rising temperatures, more intense floods, a smaller snowpack, more frequent drought, and more frequent and intense wildfires will reduce both surface and groundwater storage, as more water runs off or evaporates and less infiltrates into the ground. These changes in temperature and moisture will force species and natural communities to move with their preferred temperature and moisture regimes—uphill, northward, and into cool canyons-- until blocked by topographic or other barriers. The result is that many species and ecosystems will occupy ever smaller and more isolated patches of physical habitat. As their abundance declines, more species will risk extinction.

Two examples are especially relevant to water and flood management. First, in many low- and middle-elevation streams today, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate this problem. As the timing of peak tributary runoff shifts toward winter, less of the winter flow is likely to be captured in reservoirs. This will leave less cold water for fish in spring and summer. Thus, climate change might require dedication of more water simply to maintain existing fish habitat; and plans to expand habitat will face stiffer competition from other demands on water.

The second example results from the continued rise in sea level and upstream encroachment of salt water. As this happens, the brackish and fresh aquatic habitats of the Sacramento-San Joaquin Estuary that are critical to many at-risk species will shift upstream and inland. Continuing urbanization on the edges of the

Delta will limit opportunities to acquire or restore lands that could provide suitable habitat. Thus, threatened and endangered species could be increasingly squeezed between the inland sea and the encroaching cities.

Conflicting Objectives with Traditional Flood Management

Ecosystem restoration and traditional flood management often have conflicting objectives. Traditional flood planning assigns all the physical space in a river channel to floodwater conveyance and leaves little room for habitat values. Many of the greatest opportunities for ecosystem restoration, especially in the Central Valley and other valleys, require incorporation of habitat into the flood protection system. At this early stage in statewide flood planning, we lack consensus on how to design such an integrated system and on the desirability thereof. For example, many would balk at using newly-created flood capacity in a river channel to make room for forests.

Californians need to be satisfied that the promise of an integrated approach to flood and ecosystem management can provide habitat without greater risk of flood damage. A habitat project that fails to achieve its objectives is costly, but not dangerous. In contrast, a flood protection project that fails can mean catastrophe for life and property.

Opposition to Conversion of Farmland to Habitat

Many of the opportunities for ecosystem restoration are on land that is now farmed, especially in the Central Valley and Delta. Although some habitat types, such as seasonal wetlands, can be farmed at other times of year, others, such as riparian forest and most permanent wetlands, cannot. Thus, significant amounts of habitat restoration on arable land, coupled with continued urban growth, could hasten the decline of some forms of agriculture in California. The loss of farmland, especially for habitat uses, is controversial.

Instream Flows

Restoration of adequate instream flows and channel and floodplain form and function is a priority for the California Department of Fish and Game. DFG has legal mandates to determine flows that will ensure the viability of fish and wildlife, identify the watercourses to evaluate, initiate flow studies, and develop recommendations to the State Water Board for use in allocating water. Much work remains to complete studies and develop recommendations. Until then, incomplete knowledge will hamper restoration of adequate stream flows.

Mercury Contamination

Wetland restoration carries the potential for methyl mercury contamination. Some seasonally and permanently flooded wetlands can convert elemental mercury to methyl mercury. Methyl mercury is highly toxic and can accumulate in natural food chains and in fish that people eat. Many areas targeted for habitat restoration, particularly in and near the Delta, are contaminated with mercury. Hence, wetland restoration in those areas could exacerbate methyl mercury production. The State Water Board approved a Basin Plan Amendment for the control of methyl mercury and total mercury in the Delta in 2011. Wetland projects will be affected by the new regulation.

Recommendations to Promote Ecosystem Restoration

1. **Devise climate change adaptations that benefit both ecosystems and water and flood management.** The principal predicted effect of climate change on California ecosystems is to further fragment and shrink them. Thus, appropriate corrective actions should serve to reconnect and expand them. The overarching recommendation is to establish large biological reserve areas that connect or reconnect habitat patches. These proposed "landscape reserves" are discussed further in the biodiversity and habitat section of the California Natural Resources Agency's Climate Adaptation Strategy (2009). More specific measures that can help ecosystems adapt to climate change are those that integrate ecosystem restoration into flood and water projects. The following measures were discussed above.
   A. Re-connect rivers to their historic floodplains as part of new flood management approaches.
   B. Increase the use of setback levees and floodwater bypasses.
   C. Expand lowland riparian forest acreage in the form of continuous corridors along watercourses.
   D. Set aside habitat in the Delta to compensate for habitat lost to sea level rise.
   E. Restore mountain meadows.
   F. Enable migratory fish to move past dams and other obstructions into their historic habitat in upper watersheds.
2. **Promote multidisciplinary approaches to water and flood management.** Conflicting objectives are commonplace in water and flood planning. It is essential to foster broad participation and collaboration among the affected parties to generate a shared vision of water and flood management that incorporates multiple interests. One promising approach is to devise a system of payments for ecosystem services in which beneficiaries pay natural resource managers for practices that support and enhance the desired goods and services. Stakeholders must identify and agree on what are the relevant goods and services, the beneficiaries, and the monetary value of the benefits.
3. **Expand financial incentives for farmers to grow and manage habitat**. Programs such as the Environmental Quality Incentives Program administered by the USDA, Natural Resources Conservation Service (NRCS), California's Williamson Act subventions, and DWR's Flood Corridor grant program are examples of the direction that expansion could take. See the agricultural lands stewardship strategy in this volume for further discussion.
4. **Provide for instream flow needs.** Provide a comprehensive and appropriately funded program to identify instream flow needs, perform the necessary studies, and make scientifically defensible recommendations for instream flows to protect fish and wildlife.
5. **Continue collaboration between wetland stakeholders and Water Boards to reduce mercury contamination.** Wetland stakeholders are working with the Water Boards to identify and conduct research to reduce human and ecosystem exposure to mercury without preventing other efforts to improve ecosystem health through wetland restoration.

Ecosystem Restoration in the Water Plan

[This is a new heading for Update 2013. If necessary, this section will discuss the ways the resource management strategy is treated in this chapter, in the regional reports and in the sustainability indicators. If the three mentions aren't consistent, the reason for the conflict will be discussed (i.e., the regional reports are emphasizing a different aspect of the strategy). If the three mentions are consistent with each other (or if the strategy isn't discussed in the rest of Update 2013), there is no need for this section to appear.]

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Additional References

Personal Communications

Table 22-1 [Title to Come]

NAWCA	Acres Conserved [a]	NAWCA Grant Funding	Federal Funding [b]	Non-Federal Partners [c]
All of California	714,000	$72,000,000	$109,000,000	$230,000,000
North Central Valley/Delta	341,400	$32,300,000	$82,000,000	$85,200,000
Southern Central Valley	258,600	$21,000,000	$21,700,000	$56,600,000

[a] Habitat protected, restored, and enhanced

[b] This column reflects additional Federal partner contributions

[c] This column reflects non-federal partner contributions